Near-Inertial Wave Studies Using Historical Mooring Records and a High-Resolution General Circulation Model

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LONG-TERM GOALS

We are interested in the general problems of internal waves and ocean mixing. Knowledge of these is important for advancing the performance of operational and climate models, as well as for understanding local problems such as pollutant dispersal and biological productivity. Consequently, a long-term goal of the oceanographic community has been to develop a global internal wave prediction system analogous to those already in place for surface waves. Early steps have been accomplished with simulations of internal tide at basin and global scale (Niwa and Hibiya 2001; Simmons et al. 2004; Simmons 2008) and NIWs (Zhai et al. 2007). However, near-inertial waves and mesoscale variability have not been studied carefully in the context of global simulations. This project takes another step toward this larger goal.

OBJECTIVES

- To understand the generation mechanisms and subsequent propagation of near-inertial waves in an eddy-resolving global model.
- To validate model predictions with historical and new datasets and determine improvements.

APPROACH

Our approach is to force Simmons' eddy-resolving GOLD numerical model with wind and tides, and to examine the spatial scales and dynamics of near-inertial waves in it. Model output will be compared with historical moorings compiled by Alford.

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14. ABSTRACT

We are interested in the general problems of internal waves and ocean mixing. Knowledge of these is important for advancing the performance of operational and climate models, as well as for understanding local problems such as pollutant dispersal and biological productivity. Consequently, a long-term goal of the oceanographic community has been to develop a global internal wave prediction system analogous to those already in place for surface waves. Early steps have been accomplished with simulations of internal tide at basin and global scale (Niwa and Hibiya 2001; Simmons et al. 2004; Simmons 2008) and NIWs (Zhai et al. 2007). However, near-inertial waves and mesoscale variability have not been studied carefully in the context of global simulations. This project takes another step toward this larger goal

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WORK COMPLETED

The GOLD model has been spun up for 6 years using the Large and Yeager (2004) climatology. This climatology has been tuned to produce plausible air-sea fluxes that repeat annually, but retain realistic storm propagation, taken from a particular year, 1995. After the six-year spin-up, the simulation was continued from January 1, 1995 (with respect to the storms), in two parallel model integrations, one simply continuing the spin-up ("NO-TIDE"), and the other including the eight dominant tidal constituents ("TIDE"). Both TIDE and NO-TIDE were run for an additional three months, archiving the full three-dimensional model state every two hours, requiring multiple terabytes of data storage. Preliminary analysis and early results are discussed below.

RESULTS

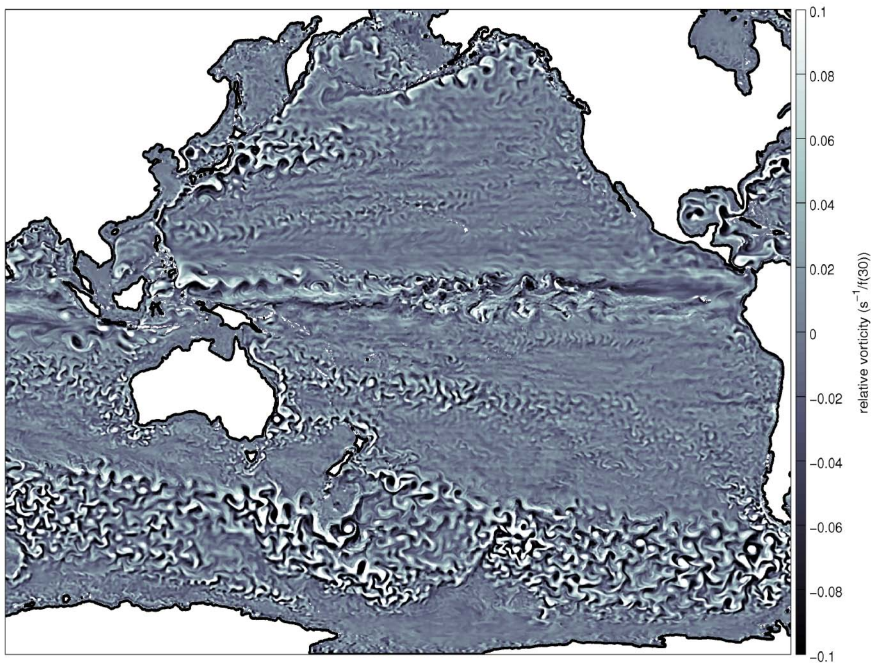

Figure 1. Surface relative vorticity at year six of the simulation.

The model resolves many familiar features of the ocean general circulation-- unstable, highly nonlinear western boundary currents, tropical instability waves, a highly turbulent Antarctic Circumpolar Current, et cetera (Figure 1). We have focused our preliminary analysis on the high-frequency (near-inertial and higher) response. We have computed the rotary spectra of the thermocline-to-surface velocity shear, a proxy for first the first baroclinic mode. Figure 2 (LHS) shows the latitudinally averaged spectra of clockwise and counter-clockwise velocity shear, revealing the strong near-inertial and internal tide response, suggesting that the model is carrying importance energy sources for internal wave spectrum. It must be stressed however that the model internal wave spectrum is much too blue, with most of the simulated internal wave energy trapped at only a few frequencies, as can be seen from a comparison between the model predicted internal wave spectrum in the Ocean Storms region, and

that from current meter records from that experiment (D'Asaro 1995), (Figure 2, RHS), though the energy in the inertial and semidiurnal tidal band compares favorably.

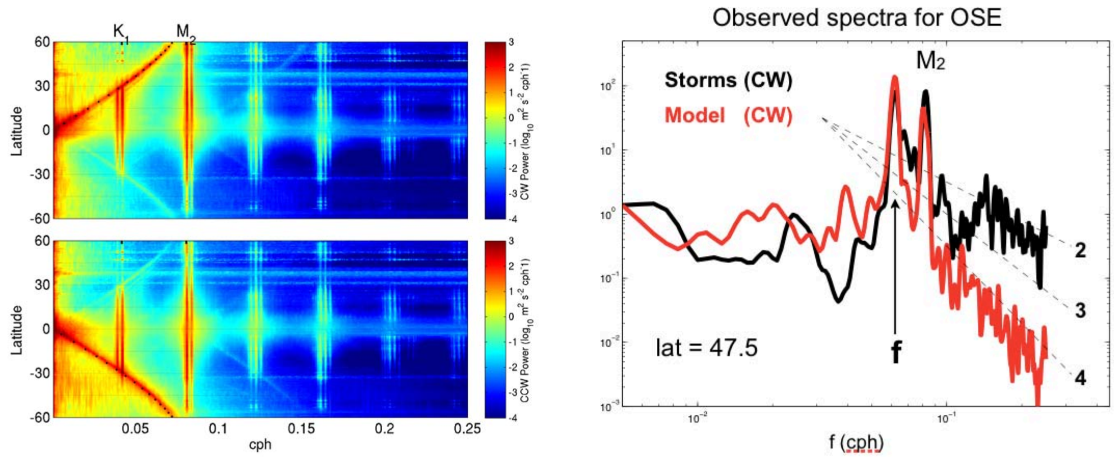

Figure 2. Left Panel: Rotary spectra of surface-to-thermocline velocity shear, averaged across each latitude in the Pacific. The diagonal signal originating from the equator, marked by black dots, is the near-inertial response. The K1 and M2 tidal frequencies are indicated. Right panel: Model versus observed spectra for the Ocean Storms experiment region. Note that Ocean Storms data was gathered in the fall and winter of 1989, whereas our model prediction is for February 1995, so the comparison is qualitative.

Depth-integrated baorclinic energy fluxes have also been calculated for the near-inertial band (Figure 3). The energy fluxes are of order 1 kW/m and are principally directed eastward and equatorward.

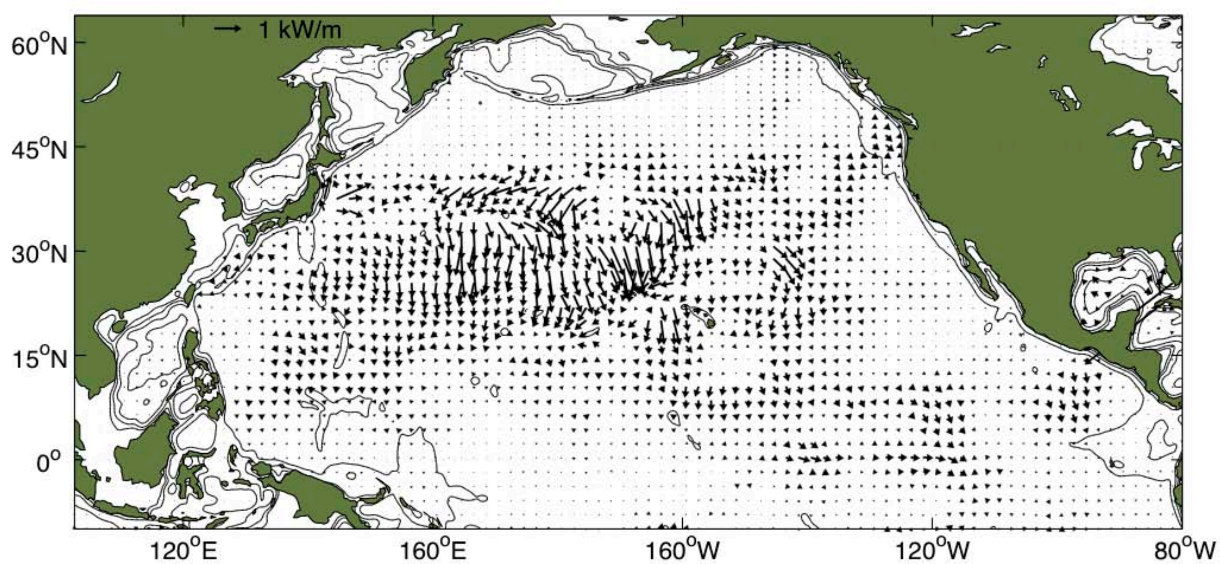

Figure 3. Depth-integrated baroclinic energy fluxes, averaged over the month of February. For clarity, the model data was smoothed over 32 grid points (nominally 4 degrees), and every 16th vector (nominally 2 degrees) is plotted.

IMPACT/APPLICATIONS

TRANSITIONS

RELATED PROJECTS

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PUBLICATIONS

No articles have been published this year on this project.